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(54) **Mobile radio terminal and surface acoustic wave antenna duplexer**

(57) An antenna duplexer is reduced in size, so that a dual-band/triple-band mobile radio terminal small in size and light in weight is realized. An off-set PLL modulation system is adopted, and a transmitting system of the antenna duplexer is constituted by switches. Further, in mounting an SAW filter, a multi-layer substrate is adopted, matching circuits and so on are formed by lumped-constant circuit elements, and the SAW filter is received in a space provided on the multi-layer substrate.

Fig. 5

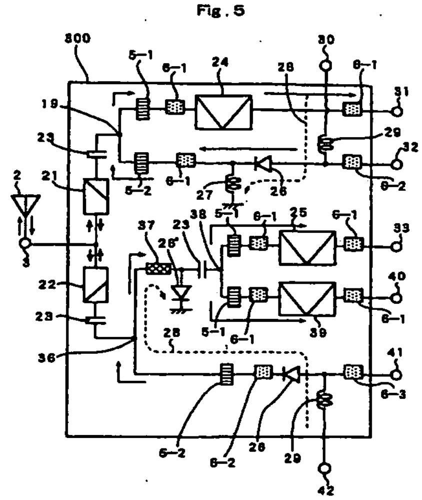

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Fig. 5 is a circuit block diagram of an SAW antenna duplexer for a triple-band mobile radio terminal;

Fig. 6 is a sectional view of an antenna duplexer;

Fig. 7 is a sectional view of an antenna duplexer;

Fig. 8 is a sectional view of an antenna duplexer;

Fig. 9 is a sectional view of an antenna duplexer;

Fig. 10 is a sectional view of an antenna duplexer;

Fig. 11 is a sectional view of an antenna duplexer;

Fig. 12 is a sectional view of an antenna duplexer;

Fig. 13 is a sectional view of an antenna duplexer;

Fig. 14 is a sectional view of an antenna duplexer;

Fig. 15 is a correlation graph between the absolute value of a reflection coefficient and the loss in parallel connection; and

Fig. 16 is a circuit block diagram of a dual-band mobile radio terminal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

(First Embodiment)

[0009] Mounting for reducing the size and weight of an SAW antenna duplexer shown in Fig. 2 is described as a first embodiment of the present invention. Figs. 3A to 3C are a sectional view, a top view and a bottom view of the antenna duplexer respectively. This embodiment uses a dielectric multi-layer substrate in which first and second dielectric substrates (upper and lower dielectric substrates) 11 and 12 are bonded with each other through a bonding agent 15. Lumped-constant circuit elements 13 (chip capacities, chip inductors, helical coils, etc.) constituting phase shift circuits and matching circuits are mounted on the upper surface of the upper dielectric substrate 11 (the uppermost surface of the dielectric multi-layer substrate). A space is provided in a portion of the lower dielectric substrate 12 so as to receive SAW filters 16. Solder-coated portions (soldering lands) 55 for mounting the lumped-constant circuit elements 13 thereon are provided on the upper surface of the upper dielectric substrate 11, and soldering lands 55 for mounting the SAW filters 16 thereon are provided on the lower surface of the upper dielectric substrate 11. On the other hand, a signal terminal or ground terminal pattern 18 is provided on the lower surface of the lower dielectric substrate 12 (the lowermost surface of the dielectric multi-layer substrate) so as to be connected with signal lines and the ground on a board (not shown). The circuit pattern on the upper surface of the upper dielectric substrate 11 is electrically connected with the SAW filters 16 and the terminal pattern on the lower surface of the lower dielectric substrate 12 through conductors in through holes 14 and castellations 17. Glass epoxy resin which is rich in degree of freedom of working and inexpensive in cost is suitable for the multi-layer substrate. Glass ceramic or the like may be also used.

[0010] According to this embodiment, the SAW filters large in volume are built in the multi-layer substrate, and the lumped-constant circuit elements constituting matching circuits, phase shift circuits, and so on are disposed on the upper surface of the multi-layer substrate, so that the SAW antenna duplexer can be made smaller in size than a related-art SAW duplexer in which SAW filters and other elements are mounted on a single-layer substrate.

[0011] The lumped-constant circuit elements mounted on the upper surface of the upper dielectric substrate 11 are not limited to the phase shift circuits and matching circuits. The following embodiment will show an antenna duplexer using switching elements such as pin diodes, gallium arsenide ICs, etc. The antenna duplexer is suitable for a dual-mode/triple-mode mobile radio terminal. Those switching elements and bias circuits for driving the switching elements are also constituted by lumped-constant circuit elements, and the lumped-constant circuit elements are mounted on the upper surface of the upper dielectric substrate 11. As a result, the increase of the volume can be suppressed also in a large-circuit-scale antenna duplexer for a dual-mode/triple-mode mobile radio terminal.

[0012] Modifications of the first embodiment will be described below with reference to Figs. 6 to 14.

[0013] In Fig. 6, the upper surface of the upper dielectric substrate mounted with lumped-constant circuit elements, switching elements and so on is covered with a metal cap 43 from above. The metal cap 43 is connected with the ground pattern provided on the upper surface of the upper dielectric substrate. The connection is provided at one or more places of the metal cap 43 through solder or the like 44. As a result, the elements, circuit pattern and so on mounted on the upper surface of the upper dielectric substrate can be protected. In addition, the grounding capacity of the antenna duplexer can be enhanced, and surrounding electromagnetic waves can be prevented from affecting the antenna duplexer.

[0014] In Fig. 7, the upper surface of the upper dielectric substrate mounted with elements and so on is covered with resin 45. As a result, the elements and circuit pattern mounted on the upper surface of the upper dielectric substrate can be protected at a low cost.

[0015] In Fig. 8, each mounted SAW filter is an SAW filter 46 received in a sheet-mounted package. The SAW filter received in a sheet-mounted package ensures the air-tightness, and makes the working of

a plurality of mixers 124 do not have a common oscillation frequency but have oscillation frequencies corresponding to the respective systems. In that case, there is an advantage that the frequency of any IF reception signal can be set so as to be adapted to any characteristic of the IF filter 128. In addition, the reception signal is not always limited to a voice signal, but it may be a data signal.

[0026] Next, description will be made about a transmitting system. The voice output from a microphone 108 is converted into a base-band transmission signal in the logic circuit 104. The base-band transmission signal is converted into an IF transmission signal by an IF modulator 172, and the IF transmission signal is supplied to an off-set phase lock loop (off-set synthesizer) 180. The off-set synthesizer is a system which is extremely low in signal output of any frequency band other than a desired transmission frequency characteristic, in comparison with an orthogonal modulation system which was a typical one as an RF modulation system in the related art. As a result, there is required no filter for reducing noise in the reception frequency band, which was required in the orthogonal modulation system after the modulation of the transmission signal into the transmission frequency band. Incidentally, such an off-set synthesizer is shown, for example, in "ISSCC 97 Digest of Technical Papers" p.302-303 (1997).

[0027] The oscillator 162-1 (2) oscillates a signal of a frequency in the transmission frequency band of the first (second) mobile communication system. The signal oscillated from the oscillator 162 is mixed with a signal from the local oscillator 140 by a mixer 168. Incidentally, the local oscillator in the transmitting system is shown in common with the local oscillator in the receiving system, merely for the sake of simplification of the drawing. The frequency of the signal oscillated from the local oscillator 140 is now equal to the frequency obtained by subtracting the frequency of the IF transmission signal from the oscillation frequency of the oscillator 162. An output signal from the mixer 168 is further mixed with the IF transmission signal from the IF modulator 172 by a mixer 170. As a result, the mixer 170 outputs a DC signal. This DC signal drives the oscillator 162 so that the IF transmission signal is modulated into a carrier-frequency (RF) transmission signal. Then, switches 164 and 166 are changed over by a not-shown control portion in the same manner as in the receiving system. A first RF transmission signal outputted from the first oscillator 162-1 is amplified by a first high power amplifier (HPA) 160-1, and a second RF transmission signal outputted from the second oscillator 162-2 is amplified by a second HPA 160-2. Then, the transmission signal is outputted to the antenna 100 through the antenna duplexer 102. Incidentally, the transmission signal is not always limited to a voice signal, but may be a data signal.

[0028] Description will be continued on the assumption that the first and second mobile communication systems are EGSM and PCN respectively. The transmitting and receiving frequency bands $f_T(1)$ and $f_R(1)$ of EGSM are in a range of from 880 to 915 MHz and in a range of from 925 to 960 MHz respectively as shown in Fig. 1A. The transmitting and receiving frequency bands $f_T(2)$ and $f_R(2)$ of PCN are in a range of from 1,710 to 1,785 MHz and in a range of from 1,805 to 1,880 MHz respectively as shown in Fig. 1B. Since the frequency bands of the two systems are thus at a large distance, there may be considered a system in which transmitting/receiving circuits adapted to the respective systems as shown in Fig. 2 are changed over by a switch in an antenna duplexer used for a dual-band mobile radio terminal. However, in such a system, the circuit scale is twice as large as a conventional one. In addition, when a switch is used for changing over the transmitting/receiving circuit, the efficiency of the switch is low because the frequencies used in EGSM and PCN are different from each other by approximately 1 GHz, so that the circuit scale further increases due to a circuit constituting the switch. Therefore, in this embodiment, it is noticed that noise in a receiving frequency band is kept in a low level even in an RF transmission signal amplified by an HPA in a low-noise RF modulation system represented by an off-set synthesizer. Since the noise in the receiving frequency band is kept in a low level in the amplified RF transmission signal, an SAW filter of a transmitting system used in a related-art antenna duplexer as shown in Fig. 2 is replaced by a switching element. As a result, it is possible to realize an antenna duplexer suitable for a dual-band/triple-band mobile radio terminal in which the circuit configuration is simplified.

[0029] Fig. 4 shows a circuit block diagram of a dual-band antenna duplexer. Blocks having similar functions to those in Fig. 2 are referenced correspondingly. An antenna duplexer 200 has a first transmitting/receiving circuit for a first mobile communication system (EGSM) and a second transmitting/receiving circuit for a second mobile communication system (PCN). The respective transmitting/receiving circuits are connected in parallel with an antenna terminal 3 through filters 21 and 22 respectively. The filters 21 and 22 are determined in accordance with frequency bands used in the respective communication systems. The filter 21 is a low pass filter which passes signals in the frequency band used in EGSM, that is, in the frequency band of not higher than 960 MHz. On the other hand, the filter 22 is a high pass filter which passes signals in the frequency band used in PCN, that is, in the frequency band of not lower than 1,710 MHz.

[0030] The first transmitting/receiving circuit includes a receiving system constituted by a phase shift circuit 5-1, a matching circuit 6-1 and an SAW filter 24, and a transmitting system constituted by a phase shift circuit 5-2, matching circuits 6-2 and 6-3, and switching circuits 26, 27 and 29. The transmitting and receiving systems are connected in parallel with each other at a

mounting when the mounting is performed by using the multi-layer substrate shown in the first embodiment. In this case, the matching circuits, the phase shift circuits, the switching circuits, the bias circuits, etc. are constituted by lumped-constant circuit elements and mounted on the upper surface of the upper dielectric substrate. In addition, the SAW filters for EGSM and PCN are received in a space provided in the lower dielectric substrate. The mobile communication systems for providing service are not always limited to EGSM and PCN, but this embodiment is applicable to an antenna duplexer adapted to a combination of other mobile communication systems such as a W-CDMA system with a 2 GHz band and so on.

(Third Embodiment)

[0042] In any country or in any region, portable telephone service was opened initially by using a system with transmitting and receiving frequency bands near an 800 MHz band. With the sudden increase of users, service based on a system with transmitting and receiving frequency bands in a 1.5 to 2.0 GHz band was started. In reflection of such circumstances of increased available frequencies, frequency bands used in respective mobile communication systems are roughly classified into ones near the 800 MHz band and ones in the 1.5 to 2.0 GHz band. Of representative mobile communication systems, systems using frequencies near the 800 MHz band include NTACS (f_R=843-870 MHz, f_T=898-925 MHz), NTT (f_R=870-885 MHz, f_T=925-940 MHz), EAMPS (f_R=869-894 MHz, f_T=824-849 MHz), ETACS (f_R=917-950 MHz, f_T-872-905 MHz), PDC800 (f_R=810-826 MHz, f_T=940-956 MHz), GSM, J-CDMA (f_R=832-870 MHz, f_T=887-925 MHz), etc. On the other hand, systems using frequencies in the 1.5 to 2.0 GHz band include PDC1.5 (f_R=1,477-1,501 MHz, f_T=1,429-1,453 MHz), PCN, PCS, W-CDMA (f_R=2,110-2,170 MHz, f_T=1,920-1,980 MHz), etc.

[0043] Currently, mobile radio terminal service adapted to three systems available in two regions is in the planning stage. For example, there is a plan to provide triple-band mobile radio terminal service in which PCS in U.S. is added to the two systems of EGSM and PCN in Europe. In this case, the transmitting and receiving frequency bands $f_T(1)$ and $f_R(1)$ of EGSM are in a range of from 880 to 915 MHz and in a range of from 925 to 960 MHz respectively as shown in Fig. 1A. The transmitting and receiving frequency bands $f_T(2)$ and $f_R(2)$ of PCN are in a range of from 1,710 to 1,785 MHz and in a range of from 1,805 to 1,880 MHZ respectively as shown in Fig. 1B. The transmitting and receiving frequency bands $f_T(3)$ and $f_R(3)$ of PCS are in a range of from 1,850 to 1,910 MHz and in a range of from 1,930 to 1,990 MHz respectively as shown in Fig. 1C. For such three mobile communication systems, it is difficult to further miniaturize an antenna duplexer. In this embodiment, from the aforementioned circumstances of mobile communication systems, there is a high possibility that the triple-band mobile radio terminal is adapted to a combination of mobile communication systems which include one 800 MHz band system and two other 1.5-2.0 GHz band systems, or two 800 MHz band systems and one other 1.5-2.0 GHz band system. Therefore, parts of circuits are shared between the two systems using neighboring frequency bands so that the circuit scale is reduced.

[0044] Description will be continued on the assumption that the first mobile communication system is EGSM, the second mobile communication system is PCN and the third mobile communication system is PCS. The circuit configuration of the triple-band mobile radio terminal is also based on Fig. 16. However, in order to make the mobile communication terminal adapt to the three mobile communication systems, three RF systems are required on the receiving system side, and oscillators of an off-set synthesizer and HPAs are required for three transmitting frequency bands on the transmitting system side.

[0045] A basic configuration of the antenna duplexer is provided with a first transmitting/receiving circuit adapted to the 800 MHz band system (EGSM), and a second transmitting/receiving circuit adapted to the 1.5-2.0 GHz band systems (PCN and PCS). In the first transmitting/receiving circuit, a first transmitting system and a first receiving system are connected in parallel with each other in the same manner as in the second embodiment. On the other hand, in the second transmitting/receiving circuit, a transmitting system is shared between PCN and PCS because PCN and PCS have transmitting frequency bands close to each other as shown in Figs. 1B and 1C. In addition, since the receiving frequency bands of PCN and PCS are close to each other and do not overlap with each other, a second receiving system adapted to PCN and a third receiving system adapted to PCS are connected in parallel with each other. Further, the receiving systems connected in parallel and the transmitting system (second transmitting system) are connected in parallel.

[0046] Thus, in the same manner as in the second embodiment, in order to restrain the leakage of a transmission signal into any receiving system and the leakage of a reception signal into any transmitting system, it is necessary that, viewed from the parallel connection point between the receiving system and the transmitting system, the impedance of the transmitting (receiving) system is made sufficiently high in the receiving (transmitting) frequency band. Further, in order to restrain the leakage of a PCN reception signal into the third receiving system and the leakage of a PCS reception signal into the second receiving system, it is necessary that, viewed from the parallel connection point between the second and third receiving systems, the impedance of the second (third) receiving system is made sufficiently high in the PCS (PCN) receiving frequency band.

[0047] Fig. 5 shows a circuit block diagram of a tri-

of the reflection coefficient of each of the transmitting and receiving systems is ensured to be not less than 0.8. Generally, as the frequency band is narrower, it is easier to keep a large absolute value of a reflection coefficient. It is therefore preferable that a frequency distance between min(the lowest frequency of $f_T(2)$, the lowest frequency of $f_T(3)$) and max(the highest frequency of $f_T(2)$, the highest frequency of $f_T(3)$) and a frequency distance between min(the lowest frequency of $f_R(2)$, the lowest frequency of $f_R(3)$) and max(the highest frequency of $f_R(2)$, the highest frequency of $f_R(3)$) are as narrow as possible. In addition, in order to separate reception signals of the two mobile communication systems, it is necessary that the receiving frequency bands of the two systems do not overlap with each other.

[0056] The above description was made about an example of a triple-band mobile radio terminal adapted to one system using a frequency band near an 800 MHz band and two systems using frequency bands in a 1.5-2.0 GHz band. However, similar configuration can be applied to a triple-band mobile radio terminal adapted to two systems using frequency bands near an 800 MHz band and one system using a frequency band in a 1.5-2.0 GHz band. In this case, a transmitting/receiving circuit corresponding to the second transmitting/receiving circuit described above is connected to a low pass filter connected to the antenna terminal 3, and a transmitting/receiving circuit corresponding to the first transmitting/receiving circuit described above is connected to a high pass filter connected to the antenna terminal 3.

[0057] The antenna duplexer shown in this embodiment can be miniaturized also from the point of view of mounting when the mounting is performed by using the multi-layer substrate shown in the first embodiment. In this case, the matching circuits, the phase shift circuits, the switching circuits, the bias circuits, etc. are constituted by lumped-constant circuit elements and mounted on the upper surface of the upper dielectric substrate. In addition, the SAW filters for EGSM, PCN and PCS are received in a space on the lower dielectric substrate. The mobile communication systems for providing service are not always limited to EGSM, PCN and PCS, but this embodiment is applicable to an antenna duplexer adapted to a predetermined combination of other mobile communications.

[0058] According to the present invention, an antenna duplexer can be miniaturized so that a dual-band/triple-band mobile radio terminal small in size and light in weight can be realized.

Claims

1. A transmitting/receiving SAW antenna duplexer sharing a single antenna between at least two different frequencies, for example, between a transmission high-frequency signal and a reception high-frequency signal, said transmitting/receiving SAW antenna duplexer comprising:

   a multi-layer substrate constituted by at least two dielectric substrate layers having signal and ground patterns formed thereon;

   at least lower one of said dielectric substrate layers being partly removed to thereby form a space in a bottom of said multi-layer substrate, so that said signal pattern and ground pattern formed on a lower surface of the other upper dielectric substrate layer is exposed in said space;

   at least one SAW filter mounted in said space and on said signal and ground patterns exposed in said space;

   at least one lumped-constant circuit element mounted on an upper surface of an uppermost one of said dielectric substrate layers; and

   signal-terminal and ground-terminal patterns to be connected to the outside, said terminal patterns being formed on a lower surface of a lowermost one of said dielectric substrate layers, said terminal patterns being connected with said signal patterns and ground patterns provided on said respective dielectric substrate layers.

2. A switching SAW antenna duplexer sharing a single antenna between at least different frequencies, for example, between transmitting systems and receiving systems, or among high-frequency signals of at least two transmitting systems and at least two receiving systems adapted to at least two different systems, said switching SAW antenna duplexer comprising:

   a multi-layer substrate constituted by at least two dielectric substrate layers having signal, ground and bias patterns formed thereon;

   at least lower one of said dielectric substrate layers being partly removed to thereby form a space in the bottom of said multi-layer substrate, so that said signal pattern and ground pattern formed on a lower surface of the other upper dielectric substrate layer is exposed in said space;

   at least one SAW filter mounted in said space and on said signal and ground patterns which are formed on a lower surface of another substrate layer exposed in said space;

   at least one lumped-constant circuit element

being $f_T(1)$ and $f_R(1)$ respectively, transmitting and receiving frequency bands of a second one of said three systems being $f_T(2)$ and $f_R(2)$, transmitting and receiving frequency bands of a third one of said three systems being $f_T(3)$ and $f_R(3)$,

wherein a signal adapted to said first system, a signal adapted to said second system and a signal adaped to said third system share an antenna terminal through a low pass filter and a high pass filter respectively;

wherein a reception signal in said frequency band $f_R(1)$ inputted from said antenna is received through said antenna terminal and sent to a receiving-system terminal adapted to said first system through said low pass filter, a first parallel connection point and an SAW filter, said first parallel connection point being a connection point between receiving and transmitting systems adapted to said first system, said SAW filter having said frequency band $f_R(1)$ as its pass band and having a reflection coefficient the absolute value of which is not less than 0.8 in the frequency band $f_T(1)$ viewed from said first parallel connection point;

wherein a transmission signal in said frequency band $f_T(1)$ is inputted to a transmitting-system adapted to said first system, and sent to said antenna terminal through a switching circuit, said first parallel connection point and said low pass filter, said switching circuit having a reflection coefficient the absolute value of which is not less than 0.8 in the frequency band $f_R(1)$ viewed from said first parallel connection point when said switching circuit is OFF;

wherein reception signals in said frequency bands $f_R(2)$ and $f_R(3)$ inputted from said antenna are received through said antenna terminal and sent to receiving-system terminals adapted to said second and third systems through said high pass filter, a third parallel connection point, a switching circuit, a fourth parallel connection point and SAW filters respectively, said third parallel connection point being a connection point between receiving and transmitting systems adapted to said second and third systems, said switching circuit having a reflection coefficient the absolute value of which is not less than 0.8 in the frequency bands $f_T(2)$ and $f_T(3)$ viewed from said third parallel connection point when said switching circuit is OFF, said fourth parallel connection point being a connection point between receiving systems of said second and third systems, one of said SAW filters having said frequency band $f_R(2)$ as its pass band and having a reflection coefficient the absolute value of which is not less than 0.8 in the frequency band $f_R(3)$ viewed from said fourth parallel connection point, the other of said SAW filters having said frequency band $f_R(3)$ as its pass band and having a reflection coefficient the absolute value of which is not less than 0.8 in the frequency band $f_R(2)$ viewed from said fourth parallel connection point;

wherein transmission signals in said frequency bands $f_T(2)$ and $f_T(3)$ adapted to the second and third systems are inputted to a transmitting-system and sent to said antenna terminal through a switching circuit, said third parallel connection point and said high pass filter, said switching circuit having a reflection coefficient the absolute value of which is not less than 0.8 in the frequency bands $f_R(2)$ and $f_R(3)$ viewed from said third parallel connection point when said switching circuit is OFF.

6. A triple-band switching SAW antenna duplexer, sharing a single antenna among three systems using different transmitting and receiving frequencies respectively, transmitting frequency bands of said three systems being $f_T(1)$, $f_T(2)$ and $f_T(3)$, receiving frequency bands being $f_R(1)$, $f_R(2)$ and $f_R(3)$, according to Claim 5;

wherein switching is performed between said low pass filer and said high pass filter, between said transmitting system adapted to said frequency band $f_T(1)$ and said transmitting system adapted to said frequency band $f_T(3)$ and between said receiving system adapted to said frequency band $f_R(1)$ and said receiving system adapted to said frequency band $f_R(3)$ so that said transmitting and receiving systems adapted to said transmitting frequency bands $f_T(1)$ and $f_T(2)$ and said receiving frequency bands $f_R(1)$ and $f_R(2)$ are connected to said antenna terminal through said low pass filter, and said transmitting and receiving systems adapted to said transmitting frequency band $f_T(3)$ and said receiving frequency band $f_R(3)$ are connected to said antenna terminal through said high pass filter.

7. A triple-band switching SAW antenna duplexer according to Claim 5 or 6, comprising:

a multi-layer substrate constituted by at least two dielectric substrate layers having signal, ground and bias patterns formed thereon;

at least lower one of said dielectric substrate layers being partly removed to thereby form a space in the bottom of said multi-layer substrate, so that said signal pattern and ground pattern formed on a lower surface of the other upper dielectric substrate layer is exposed in said space;

at least three SAW filters mounted in said space and on said signal and ground patterns which are formed on a lower surface of another substrate layer exposed in said space;

at least one lumped-constant circuit element

duplexer according to any one of Claims 1 to 21, wherein parts of said lumped-constant or distributed-constant circuit elements are formed by a pattern on the same surface on which said SAW filter is mounted.

23. A transmitting/receiving or switching SAW antenna duplexer according to any one of Claims 1 to 21, wherein at least one intermediate layer formed of a conductor is provided between an upper surface of an uppermost one of said substrate layers or a lower surface of a lowermost one of said substrate layers and a substrate surface on which said SAW filter is mounted, and parts of said lumped-constant or distributed-constant circuit elements are formed by a pattern on said intermediate layer.

24. A mobile radio terminal wherein a transmitting/receiving or switching SAW antenna duplexer according to any one of Claims 1 to 2 and 8 to 23 is mounted so as to be miniaturized in size.

25. A dual-band mobile radio terminal wherein a dual-band switching SAW antenna duplexer according to any one of Claims 3 to 4 and 8 to 23 is mounted so as to be miniaturized in size.

26. A triple-band mobile radio terminal wherein a triple-band switching SAW antenna duplexer according to any one of Claims 5 to 23 is mounted so as to be miniaturized in size.

27. A mobile radio terminal comprising:

an antenna duplexer for separating a transmission signal in a transmitting frequency band and a reception signal in a receiving frequency band;

a demodulating circuit for demodulating said reception signal outputted from said antenna duplexer; and

a modulating circuit for modulating a base-band transmission signal into a transmission signal in said transmission frequency band through an off-set synthesizer;

said antenna duplexer including a reception system in which said reception signal in said receiving frequency band is outputted from an antenna through an SAW filter to said demodulating circuit, and a transmission system in which said transmission signal in said transmitting frequency band is outputted from said modulating circuit to said antenna through a switching element.

Fig . 2

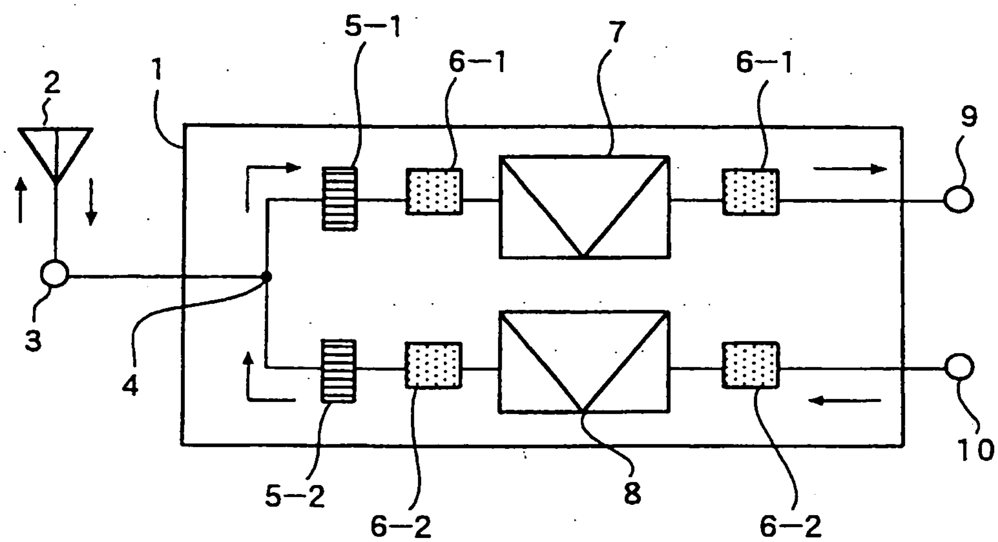

Fig. 4

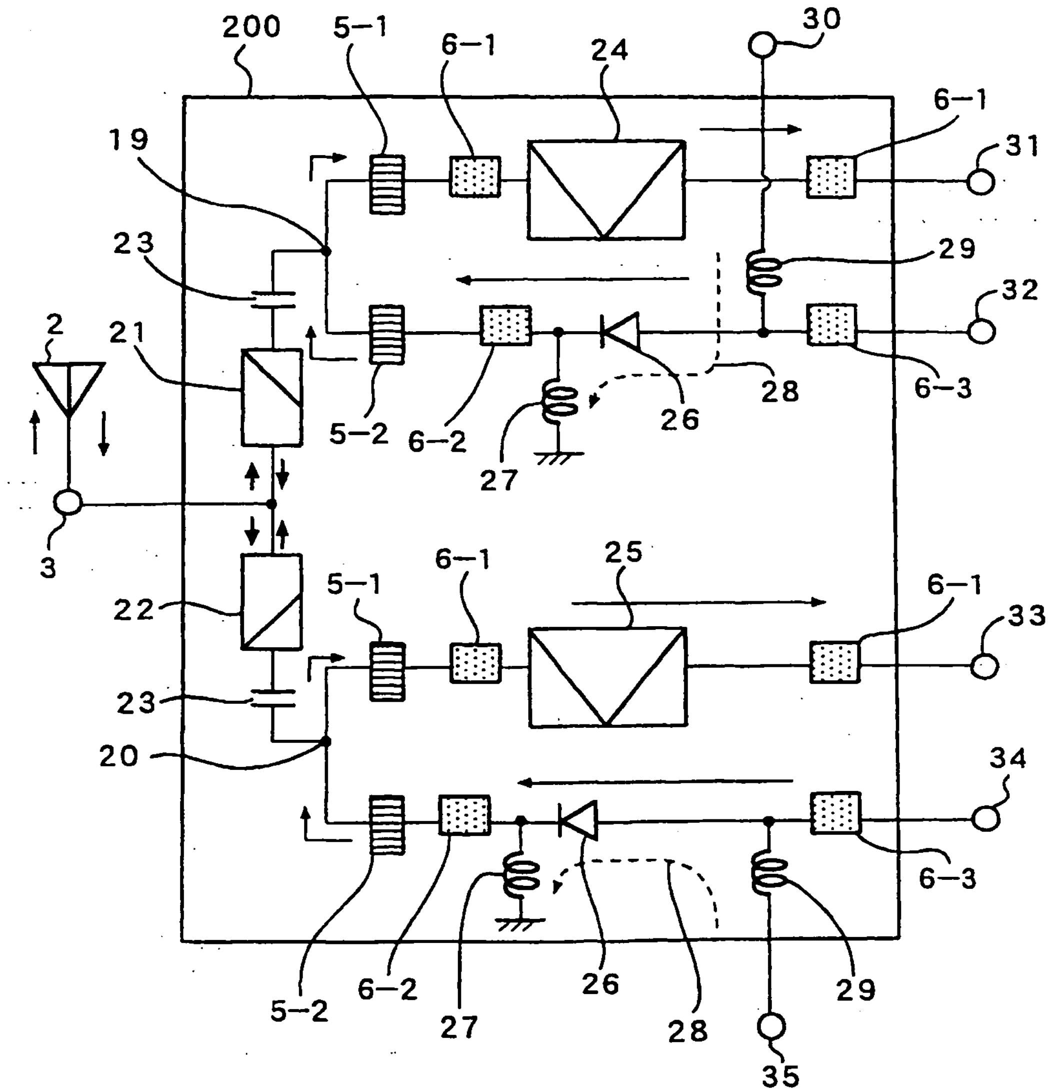
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Fig . 6

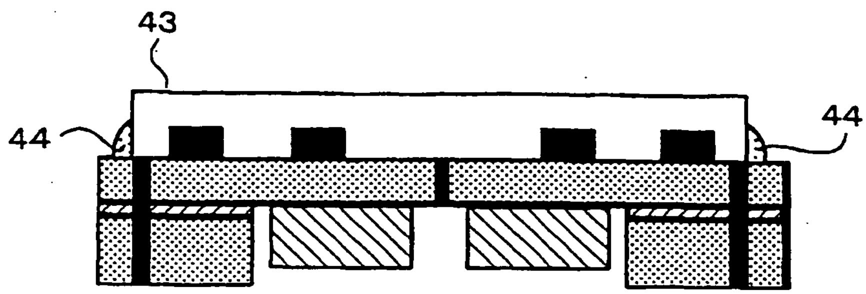


Fig . 7

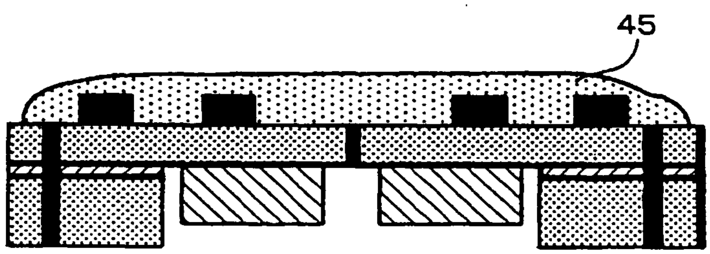


Fig . 8

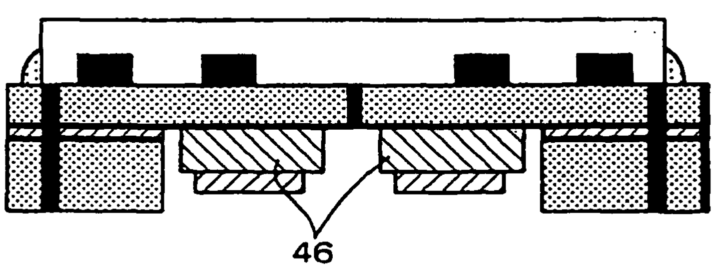


Fig. 13

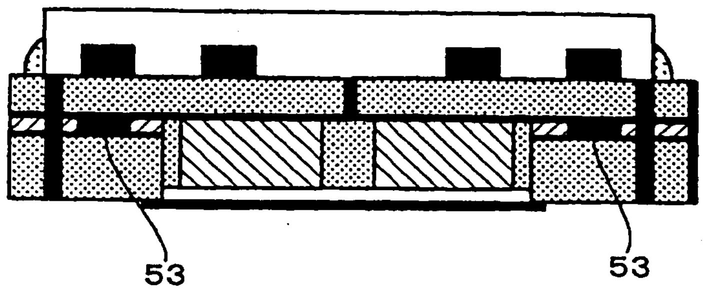
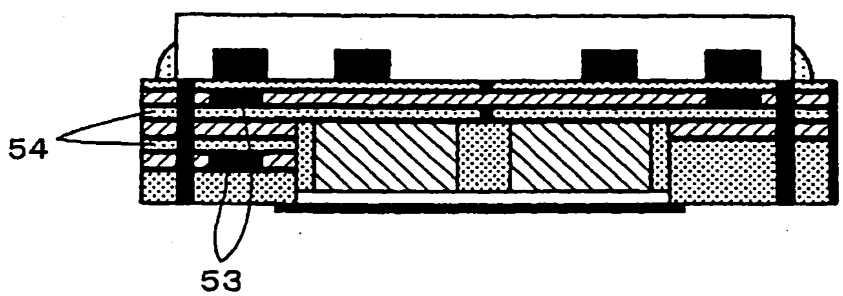
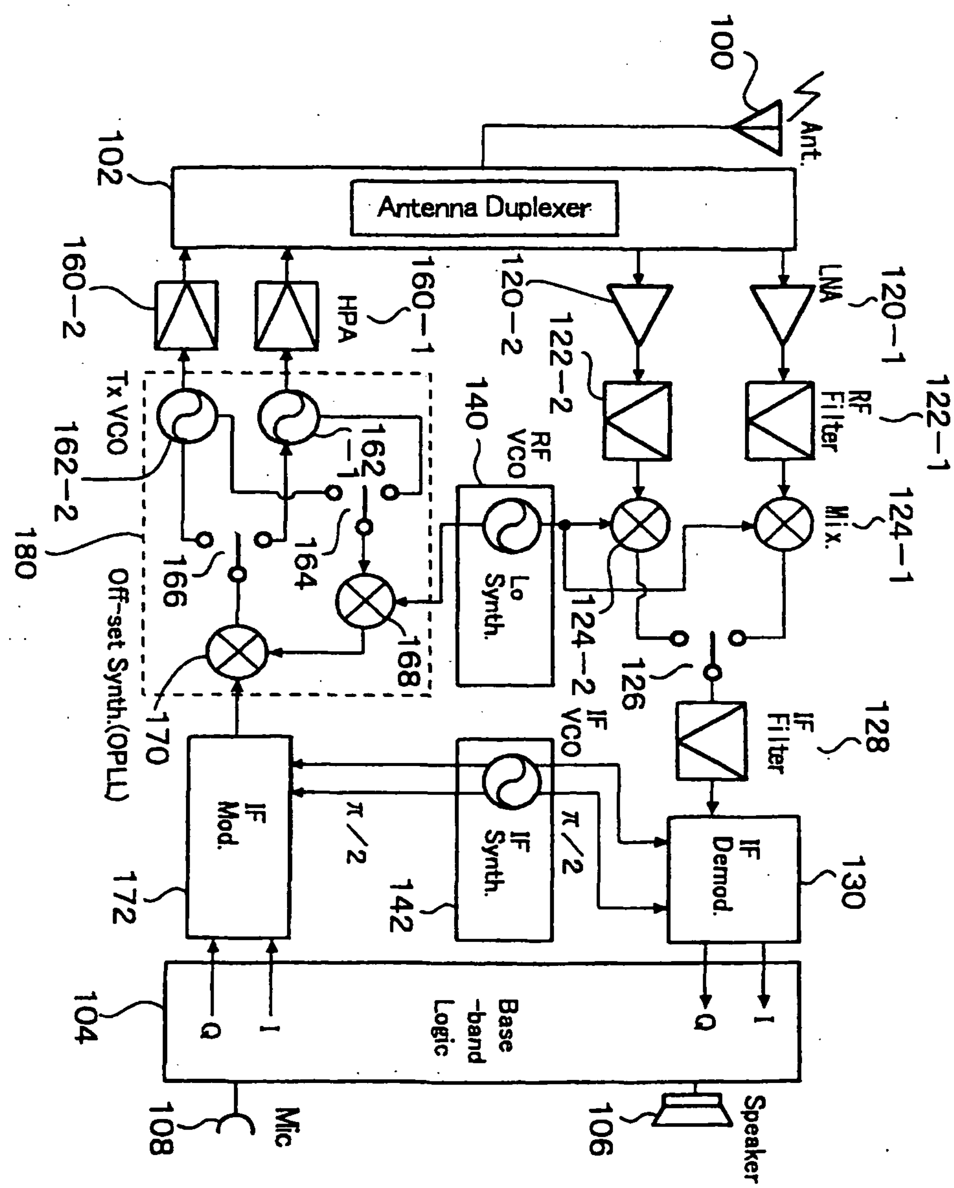


Fig. 14





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120-1
120-2
RF Filter
122-1
122-2
Mix.
124-1
124-2
126
IF Filter
128
IF Demod.
130
RF VCO
140
Lo Synth.
IF VCO
IF Synth.
142
π/2
π/2
HPA
160-1
160-2
Tx VCO
162-1
162-2
164
166
168
170
Off-set Synth.(OPLL)
180
IF Mod.
172
Base -band Logic
104
I
Q
I
Q
Speaker
106
Mic
108

Fig. 16